

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property
Organization
International Bureau



(43) International Publication Date
6 January 2005 (06.01.2005)

PCT

(10) International Publication Number
WO 2005/000493 A1

(51) International Patent Classification⁷: B21C 23/00 (74) Agent: OUTOKUMPU OYJ, INTELLECTUAL PROPERTY MANAGEMENT; P.O. Box 27, FIN-02201 Espoo (FI).

(21) International Application Number: PCT/FI2004/000365 (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(22) International Filing Date: 14 June 2004 (14.06.2004) (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

(25) Filing Language: Finnish (26) Publication Language: English

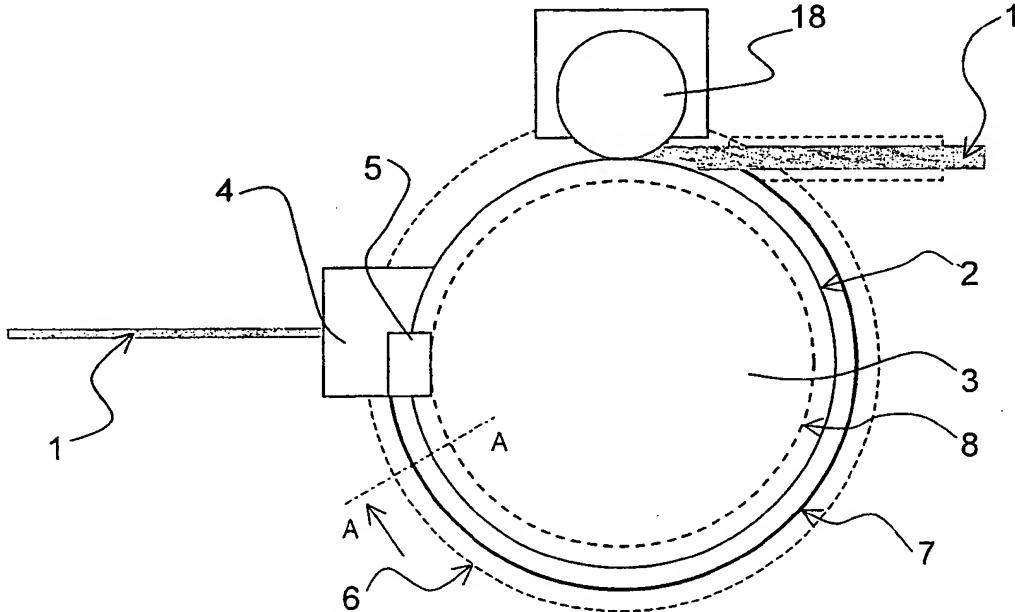
(30) Priority Data: 20030956 27 June 2003 (27.06.2003) FI (71) Applicant (for all designated States except US): OUTOKUMPU OYJ [FI/FI]; Riihitontuntie 7, FIN-02200 Espoo (FI).

(72) Inventor; and (75) Inventor/Applicant (for US only): LEIPONEN, Matti [FI/FI]; Jaalaranta 6 C 48, FIN-00180 Helsinki (FI).

{Continued on next page}

(54) Title: METHOD AND EQUIPMENT FOR PERFORMING CONTINUOUS EXTRUSION

WO 2005/000493 A1



(57) Abstract: The invention relates to a method for performing continuous extrusion of a metallic material, such as copper, so that the material to be extruded (1) is fed in the extrusion member (4) by means of a feed member (3) provided with a groove on its peripheral wall (2) and by an abutment (5) arranged in said groove, so that the groove (8) is protected against oxidation by arranging for at least part of the peripheral wall (2) of the feed member (3) a gas-protecting member (7). The invention also relates to said equipment.

**Declarations under Rule 4.17:**

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG)*
- *of inventorship (Rule 4.17(iv)) for US only*

Published:

- *with international search report*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD AND EQUIPMENT FOR PERFORMING CONTINUOUS EXTRUSION

The invention relates to a method and equipment according to the independent claims for performing continuous extrusion of a metallic material, such as copper.

5

In continuous extrusion, the material to be extruded is conducted in a groove made on the outer circumference of a wheel-like element. As the element rotates around its axis, the material to be extruded gets into contact with an abutment that essentially fills the groove, so that the motion of the material to be extruded is changed with respect to the wheel-like member. Thus the material is arranged to be extruded in the proceeding direction of the material before the abutment, through a passageway arranged in the extrusion member. The method utilizes friction and thermal energy created in the working process. By means of the method, it is possible to advantageously extrude essentially long objects that are different in their transversal surfaces.

In the course of the process, it is possible that on the surface of objects made of copper or copper alloys, there are created oxide layers that are harmful in the further processing of said objects. In traditional extrusion, in the vicinity of the surface there may be created oxide layers that result in the tearing of the structure in hydrogen annealing. When welding thin strips into tubes, oxides may create leakages in the welding area. Surfaces must be cleaned several times of the oxide layers accumulated thereon. Oxide layers are difficult to detect or measure on the surface of copper, and they are not necessarily distinguished without special equipment. The removal of thick oxide layers from the surface of copper is fairly simple, but the removal of the last molecular layers has turned out to be more difficult.

In traditional continuous extrusion, oxides are removed as so-called extrusion scrap, the processing and recirculation of which bring forth disadvantageous extra

expenses. In addition, the creation of hot extrusion scrap results in an intensive wearing of the extrusion tools. Even if oxides were removed from the surface of the feed material before the continuous extrusion, oxidation could also take place during the extrusion of the material. When manufacturing a copper product by 5 extrusion, a completely oxygen-free process would ensure a better quality for the product. It is well-known that in order to solve said problem, the extrusion equipment is protected by surrounding the equipment by an atmosphere that prevents the passage of oxides and other impurities in the extruded product. However, it has been found out that even slight oxygen-contents in the protecting 10 gas may cause oxidation that is harmful for the product. Also the groove lining may be oxidized owing to a too high oxygen level in the gas protection, which may cause occasional flaws in the products.

In the patent publication US 5,782,120, there is described an equipment for continuous extrusion, where the feed member, i.e. a wheel, included in the 15 extrusion equipment is protected by a hood containing non-oxidizing gas.

The object of the present invention is to introduce a novel solution for performing continuous extrusion of a material. A particular object of the invention is to introduce a solution where the product created in continuous extrusion is protected against oxidation.

20

The invention is characterized by what is set forth in the characterizing parts of the independent claims. Other preferred embodiments of the invention are characterized by what is set forth in the other claims.

25 Remarkable advantages are achieved by the arrangement according to the invention. The invention relates to a method for performing continuous extrusion of a metallic material, such as copper, so that the material to be extruded is fed in the extrusion member by means of a feed member provided with a groove on its peripheral wall and an abutment arranged in the groove; the groove is protected

against oxidation by providing at least part of the peripheral wall of the feed member with a gas-protecting member. The gas-protecting member according to the invention advantageously enables the feeding of non-oxidizing gases in the groove area, which in turn prevents the passage of oxygen and oxides in the

5 extrusion product. The gas-protecting member according to the invention is arranged at least on that part of the peripheral wall that does not contain material to be extruded, and the gas-protecting member covers at least part of the surface of the peripheral wall of the feed member in the width direction thereof. Thus the oxidation of the groove is particularly prevented at the hottest spot of the feed

10 member, on the peripheral wall of the feed member after the abutment, where the material to be extruded is removed from the groove. The hot surface of the groove lining is a remarkable source of oxides and consequently enhances the oxidation of the product. According to the invention, the gas-protecting member is arranged on the peripheral wall of the feed member, so that it covers at least the groove, in

15 which case the space left between the gas-protecting member and the feed member is arranged to be oxygen-free. In the space left between the gas-protecting member and the feed member, there is fed non-oxidizing gas, such as hydrogen or hydrogen and nitrogen, by means of the gas-protecting member. The gas can be preheated up to for example 400 – 800 degrees. According to a

20 preferred embodiment of the invention, oxygen is removed from the gas to be fed in prior to feeding it in the space left between the gas-protecting member and the feed member. Oxygen can be removed by using prior art methods, such as filtering. Thus even extremely low oxygen contents can be eliminated. Hydrogen can advantageously be used for removing oxygen from neutral gases. Nitrogen is

25 fed in for circulation-technical reasons. According to the invention, the extrusion process is surrounded by an inert gas protection, and the effects of the residual oxygen contained by said gas protection are eliminated by applying the solution of the invention. In the space left between the gas-protecting member and the feed member, i.e. in the vicinity of the groove, there prevails a higher pressure than in

the inert gas protection, and the gas circulation is thus directed away from the groove.

The invention also relates to an equipment for performing continuous extrusion of
5 metallic material, such as copper, so that the material to be extruded is fed in the extrusion member by means of a feed member provided with a groove on its peripheral wall and an abutment arranged in the groove, so that at least part of the peripheral wall of the feed member is provided with a gas-protecting member for protecting the groove against oxidation.

10

According to a preferred embodiment of the invention, the gas-protecting member comprises at least one protecting member provided with at least one gas channel for feeding gas into the space left between the gas-protecting member and the feed member. Thus the gas can be conducted, through the gas-protecting
15 member, in a desired spot in the groove. According to an embodiment of the invention, the gas-protecting member comprises an inner protecting member and at least one outer protecting member. According to the invention, the gas fed in from the inner protecting member has a higher pressure than the gas fed in from the outer protecting member. There is thus created a circulation away from the
20 groove through the gap left between the protection member and the feed member. On both sides of the groove, on the peripheral wall of the feed member, there is provided at least one lining element for sealing the gap between the gas-protecting member and the feed member. The lining element is made of the same material as the material to be extruded. Thus the residual oxygen from the gas protection
25 surrounding the whole extrusion equipment is advantageously prevented from accessing the vicinity of the groove.

The solution according to the invention enables the creation of an oxygen-free space in the groove vicinity, which enhances the manufacturing of a flawless
30 extrusion product. Consequently, the drawbacks caused by the processing and

recirculation of extrusion scrap are avoided, because the creation of extrusion scrap is prevented.

The invention is described in more detail below with reference to the appended
5 drawings.

Figure 1 An equipment according to the invention

Figure 2 An equipment according to the invention

10

Figure 3 An equipment according to the invention

Figure 1 illustrates how, according to the invention, the material to be extruded 1, such as copper wire, is fed in the groove 8 located on the peripheral wall 2 of the
15 feed member 3 by means of a pressure roller 18. The feed member 3 rotates around its axis, and the material to be extruded moves along the groove to the extrusion member 4 to be extruded. In connection with the extrusion, the temperature of the material to be extruded rises owing to the friction forces up to the temperature range of 550 – 750 degrees. In order to direct the material to be
20 extruded to the extrusion member 4, the groove of the feed member is provided with an abutment 5 that extends over part of the length of the wheel groove. In the extrusion member 4, there is made a passageway of a desired shape, and the extrusion product is conducted out of the feed member 3 through said
25 passageway. The extrusion process is throughout protected by a protective gas 6 against external room air. In the drawing, there is distinguished the gas-protecting member 7 arranged on part of the peripheral wall.

Figures 2 and 3 show how the gas-protecting member 7 according to the invention is arranged in the vicinity of the groove 8. Figures 2 and 3 are cross-sectional
30 views of figure 1, seen along the line A – A. According to the invention, for at least

part of the peripheral wall 2 of the feed member, there is arranged a gas-protecting member 7 in order to protect the groove against oxidation. According to the example of the invention, the gas-protecting member is arranged on that part of the peripheral wall 2 that does not contain material to be extruded. By means of the

5 gas-protecting member 7, the vicinity of the groove 8 of the feed member 3 is set in an oxygen-free atmosphere, which enhances the creation of a flawless and high-quality extrusion product. The gas-protecting member 7 is made of some wear-resistant material, such as steel, and in shape, it may conform for example to the peripheral wall 2 of the feed member 3. The gas-protecting member covers at least

10 part of the surface of the peripheral wall 2 in the width direction, and at least it covers the groove 8. According to the invention, the space 9 left between the gas-protecting member and the feed member is arranged to be oxygen-free by feeding in a desired amount of non-oxidizing gas. According to the invention, in the space 9 there is fed a gas mixture, heated up to the temperature of 600 degrees and

15 containing hydrogen and nitrogen. The non-oxidizing gas can be removed through a specially arranged removal route.

The gas-protecting member 7 according to the example, illustrated in figure 2, includes a protecting member 10 provided with at least one gas channel 11,

20 through which gas can be fed into the space 9 left between the feed member 3 and the gas-protecting member. When necessary, the gas channel can extend along the whole length of the gas-protecting member 7, or only along part of its length. Gas can be fed in at desired spots in the groove 9. The groove is provided with a lining 12 that protects the groove from wearing. Advantageously the lining is made

25 of the same material as the material to be extruded, such as copper. In between the gas-protecting member and the feed member, on both sides of the groove, there are arranged lining elements 13 in order to seal the gap 17 between the gas-protecting member and the feed member.

Figure 3 illustrates an embodiment of the invention, according to which the gas-protecting member 7 comprises an inner protecting member 10 and at least one outer protecting member 14. The outer protecting member includes at least one gas channel 15, through which non-oxidizing gas can be fed. The gas fed in

5 through the inner protecting member 10 has a higher pressure than the gas fed in through the outer protecting member 14. Thus the gas space 16 left between the outer protecting member 14 and the inner protecting member 10 has a lower pressure than the space 9 left between the inner protecting member and the feed member. Consequently, the gas is made to flow in the desired direction, away from

10 the groove. In addition, on both sides of the groove, on the peripheral wall 2 of the feed member 3, there are arranged lining elements 13, essentially so that they seal the gap 17 left between the gas-protecting member and the feed member, however so that gas can flow out of the groove 8.

15 For a man skilled in the art, it is obvious that the various preferred embodiments of the invention are not restricted to the examples described above, but may vary within the scope of the appended claims.

CLAIMS

1. A method for performing continuous extrusion of a metallic material, such as copper, so that the material to be extruded (1) is fed in the extrusion member (4) by means of a feed member (3) provided with a groove on its peripheral wall (2) and by an abutment (5) arranged in said groove, and the groove (8) is protected against oxidation by arranging for at least part of the peripheral wall (2) of the feed member (3) a gas-protecting member (7),
5 characterized in that the pressure in the space (9) left between the gas-protecting member and the feed member is higher than the pressure in the surrounding atmosphere.
10. A method according to claim 1, characterized in that the gas-protecting member (7) is arranged at least in that part of the peripheral wall (2) that does not contain material to be extruded.
15. A method according to claim 1 or 2, characterized in that the gas-protecting member (7) covers at least part of the surface of the peripheral wall (2) of the feed member in the direction of the width thereof.
20. A method according to claim 1, characterized in that the gas-protecting member covers at least the groove (8).
25. A method according to any of the preceding claims, characterized in that in the space (9) left between the gas-protecting member and the feed member, there is fed non-oxidizing gas by means of the gas-protecting member (7).
30. A method according to claim 5, characterized in that in the space (9) left between the gas-protecting member and the feed member, there is fed hydrogen.

7. A method according to claim 5, **characterized** in that in the space (9) left between the gas-protecting member and the feed member, there is fed hydrogen and nitrogen.
5
8. A method according to claim 5, 6 or 7, **characterized** in that the gas is advantageously preheated up to 400 – 800 degrees.
9. A method according to claim 5, 6, 7 or 8, **characterized** in that oxygen is
10 removed from the gas by filtering before feeding the gas into the space (9) left between the gas-protecting member and the feed member.
10. A method according to any of the preceding claims, **characterized** in that the whole extrusion process is surrounded by an inert gas protection (6).
15
11. A method according to any of the preceding claims, **characterized** in that the pressure in the space (9) left between the gas-protecting member and the feed member is higher than the pressure in the inert gas protection (6).
- 20 12. Equipment for performing continuous extrusion of a metallic material, such as copper, where the material to be extruded (1) is fed in the extrusion member (4) by means of a feed member (3) provided with a groove on its peripheral wall (2) and by an abutment (5) arranged in said groove, and the groove is protected against oxidation by arranging for at least part of the peripheral wall (2) of the feed member (3) a gas-protecting member (7),
25 **characterized** in that the pressure in the space (9) left between the gas-protecting member and the feed member is arranged to be higher than the pressure in the surrounding atmosphere.

13. An equipment according to claim 12, **characterized in that** the gas-protecting member (7) comprises at least one protecting member (10) provided with at least one gas channel (11) for feeding gas into the space (9) left between the gas-protecting member and the feed member.

5

14. An equipment according to claim 13, **characterized in that** the gas-protecting member (7) comprises an inner protecting member (10) and at least one outer protecting member (14).

10

15. An equipment according to claim 14, **characterized in that** the gas fed in through the inner protecting member (10) has a higher pressure than the gas fed in through the outer protecting member (14).

15

16. An equipment according to any of the preceding claims, **characterized in that** on both sides of the groove, on the peripheral wall of the feed member, there is arranged at least one lining element (13) in order to seal the gap (17) left between the gas-protecting member and the feed member.

20

17. An equipment according to claim 16, **characterized in that** the lining element is made of the same material as the material to be extruded.

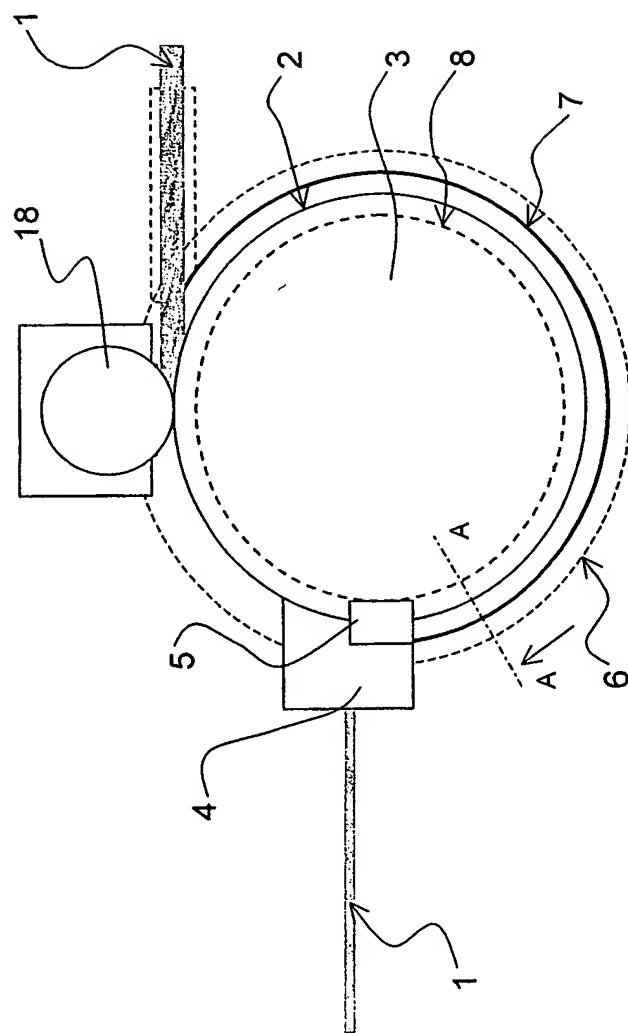


Fig. 1

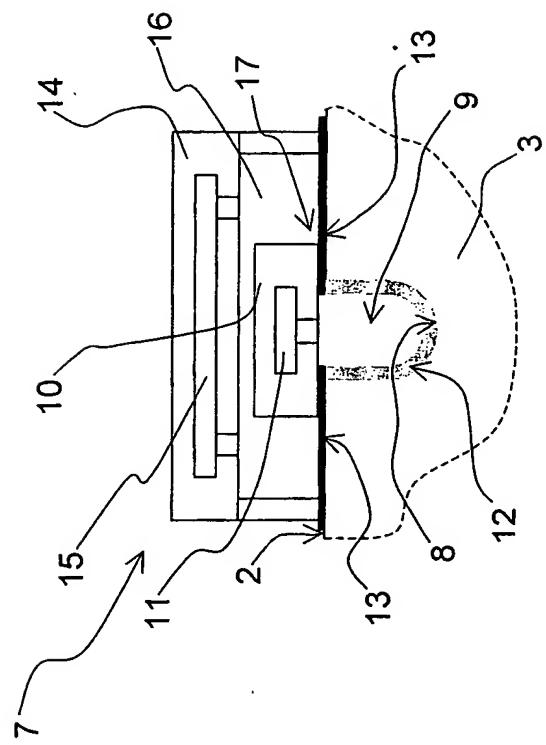


Fig. 3

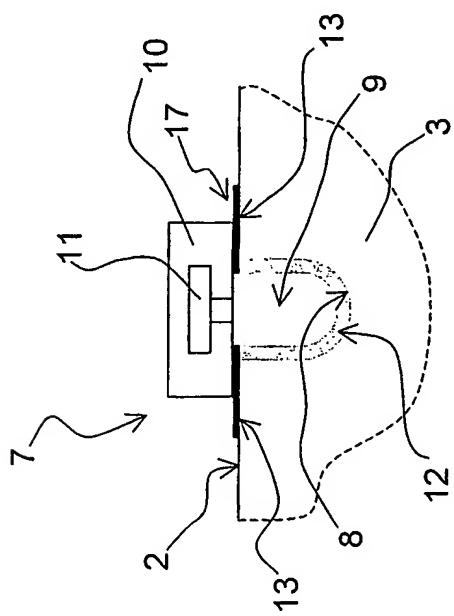


Fig. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/000365

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B21C 23/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: B21C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2241660 A (UNITED KINGDOM ATOMIC ENERGY AUTHORITY), 11 Sept 1991 (11.09.1991), abstract --	1-17
A	US 5133126 A (TATSURU MATSUOKA), 28 July 1992 (28.07.1992), abstract --	1-17
D,A	US 5782120 A (ROBERT RODGER WRIGHT), 21 July 1998 (21.07.1998), abstract --	1-17
A	WO 9014176 A1 (BWE LIMITED), 29 November 1990 (29.11.1990), abstract --	1-17

Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

27 October 2004

Date of mailing of the international search report

28-10-2004

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86

Authorized officer

Katarina Ekman/MP
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 2004/000365

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4316373 A (FRANZ-JOSEF ZILGES ET AL), 23 February 1982 (23.02.1982), abstract --	1-17
A	JP 09323104 A (GONDA KINZOKU KOGYO KK), 16 December 1997 (16.12.1997) --	1-17
A	JP 10166035 A (HITACHI CABLE LTD), 23 June 1998 (23.06.1998) -----	1-17

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.	
PCT/FI 2004/000365	

GB	2241660	A	11/09/1991	DE	9100810	U	11/04/1991
				GB	9006854	D	00/00/0000
				GB	9100671	D	00/00/0000
				JP	6005711	U	25/01/1994

US	5133126	A	28/07/1992	AU	610427	B	16/05/1991
				AU	3942289	A	15/02/1990
				CA	1330505	A,C	05/07/1994
				JP	2046913	A	16/02/1990
				JP	2661976	B	08/10/1997

US	5782120	A	21/07/1998	AU	1276495	A	10/07/1995
				BR	9408397	A	12/08/1997
				CA	2179717	A	29/06/1995
				CN	1142206	A	05/02/1997
				EP	0735929	A	09/10/1996
				GB	9326050	D	00/00/0000
				JP	9507434	T	29/07/1997
				NO	962648	A	08/08/1996
				WO	9517270	A	29/06/1995
				CA	2142394	A	15/08/1995
				EP	0671413	A	13/09/1995
				GB	9402767	D	00/00/0000
				JP	7258108	A	09/10/1995

WO	9014176	A1	29/11/1990	AT	102091	T	15/03/1994
				AU	628993	B	24/09/1992
				AU	5727990	A	18/12/1990
				CA	2032480	A,C	19/11/1990
				DE	69006913	D,T	01/09/1994
				DK	398747	T	28/03/1994
				EP	0398747	A,B	22/11/1990
				SE	0398747	T,3	
				ES	2049924	T	01/05/1994
				FI	910259	D	00/00/0000
				GB	8911466	D	00/00/0000
				NO	175739	B,C	22/08/1994
				NO	910170	A	15/01/1991
				SU	1839645	A	30/12/1993
				US	5152163	A	06/10/1992
				ZA	9003832	A	26/06/1991
				GB	8915138	D	00/00/0000

US	4316373	A	23/02/1982	AU	522326	B	27/05/1982
				AU	3943478	A	06/03/1980
				DE	2739800	A	22/03/1979
				ES	472752	A	16/02/1979
				FR	2401710	A	30/03/1979
				GB	2005173	A,B	19/04/1979
				IT	1113095	B	20/01/1986
				IT	7826970	D	00/00/0000
				JP	54049969	A	19/04/1979
				PL	209118	A	02/07/1979
				US	4192162	A	11/03/1980

JP	09323104	A	16/12/1997	NONE
----	----------	---	------------	------

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/FI 2004/000365

JP 10166035 A 23/06/1998 JP 3201293 B 20/08/2001

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- BLACK BORDERS**
- IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- FADED TEXT OR DRAWING**
- BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- SKEWED/SLANTED IMAGES**
- COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- GRAY SCALE DOCUMENTS**
- LINES OR MARKS ON ORIGINAL DOCUMENT**
- REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.